Power R&D Improves Materials Processes For Auto Industry

Automobile manufacturers are looking for new ways to quickly produce automotive parts, such as the gears in automotive power trains that meet demanding performance requirements. Traditional manufacturing methods, such as using high-pressure forming and punch presses on blanks, are quick but they leave jagged edges and rough surfaces that require postmachining—a time-consuming process.

One alternative to traditional methods is powder metallurgy, a process in which metal powders are compacted into smooth shapes, eliminating the need for polishing and finishing. Powder metallurgy is used for some components in the automotive industry, but it has not yielded the densities required for very rugged, high-performance components. Such components are still stamped or forged, making them costly to manufacture.

Applying power technology from a BMDO SBIR, IAP Research, Inc. (Dayton, OH), has developed a technique called dynamic magnetic compaction (DMC) that makes powders used in powder metallurgy dense enough to be used for high performance automotive parts. The process both speeds manufacturing and improves the quality of the parts, thereby saving the automotive industry money and time.

IAP RESEARCH MAY SAVE AUTO MAKERS TIME AND MONEY BY SPEEDING UP THEIR PARTS MANUFACTURING CAPABILITIES.

IAP is leading an $8.4 million cost-shared Advanced Technology Program project awarded by the National Institute for Standards and Technology to further develop DMC. IAP has teamed with General Motors Powertrain Division and Zenith Sintered Metal Products; the team will contribute $4.3 million to the project and is focusing on complex automotive transmission components. IAP plans to produce and sell the electromagnetic parts-making equipment to car parts manufacturers such as its joint venture partner, Zenith Sintered Metal Products, which will then sell parts to General Motors and other major manufacturers.

Researchers at IAP believe manufacturers using DMC can make a complete gear, including the teeth, in less than a second. Starting with powdered steel, the process uses high-pressure pulses generated by an electromagnet to compress the powder into a die to make a solid part. The pressures are equivalent to those under a 4,000-pound weight supported on a three penny nail. A second step in the process sinters or "bakes" the part to strengthen it. BMDO originally funded IAP's development of electromagnetic power supplies for rail gun accelerators used in space to destroy enemy missiles. This power technology is central to the compaction technique.

IAP Research's process has been used to form metal rods, as shown above. Powder is loaded into a copper tube (right) and the compaction process forms the powder into a nearly fully-dense rod (left).

About The Technology

In DMC, high currents are passed through a compactor coil from an electromagnetic power supply system. The metal powder is enclosed in a confining container and placed at the center of the compactor coil. For electrically nonconducting powders, the confining container has to be conductive; for conductive powders, this restriction does not apply. The currents in the compactor coil generate magnetic fields that produce magnetic pressures on the powder, consolidating it. This pressure is directed radially inward on the powder. While conventional techniques apply pressure from the top and the bottom, the IAP method applies pressure from outside in, along the whole length of the part.

Pulsed magnetic forces have two advantages over mechanical forces: (1) very high forces can be generated with a small, low-cost system; (2) the forces can be applied with great precision in time and space. The short pulses permit high repetition rates while offering the possibility of dynamic effects in the powder; that is, the particles compress and heat during the very short pulse, softening and becoming more plastic. This phenomenon may increase the density of the part.